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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/023,125

12/17/2001

Jong Hyun Yoo

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EXAMINER

SMITH, FRANCIS P

ART UNIT

PAPER NUMBER

1792

MAIL DATE

DELIVERY MODE

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/023,125	Applicant(s) YOO ET AL.	
	Examiner Francis P. Smith	Art Unit 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on 17 December 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) 25-30 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 March 2008 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of Group I in the reply filed on April 3, 2008 is acknowledged. The traversal is on the ground(s) that the examination of Groups I and II, drawn to a process and a system for depositing a metal film, respectively, would not pose an undue burden on the examiner. This is not found persuasive because Inventions I and II belong in separate statutory categories, are mutually exclusive, and thus would require separate search queries.

The requirement is still deemed proper and is therefore made FINAL.

2. Claims 25-30 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in the reply filed on April 3, 2008. Claims 1-24 are currently pending and examined on the merits.

Response to Arguments

3. Applicant's arguments, filed March 13, 2008, with respect to the rejection(s) of claim(s) 1-24 under 112 2nd paragraph, 102 (b), and 103 (a) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made as follows.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1, 4, 11-14, 16-19, and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by Rajagopalan et al. (WO 98/51838).

Rajagopalan teaches a multiple step chemical vapor deposition process for depositing a tungsten layer on a substrate. For claims 1, 4, 11, 14, and 17 a substrate is heated (pg. 12, lines 25-26);

a process gas consisting a metal source (tungsten hexafluoride) and a hydrogen source (silane) (claims 11 and 17) are introduced into and removed from a processing chamber (i.e. controlling production of a concentration boundary layer by removing said process gas from said processing chamber after commencement of nucleation of said substrate) (pg. 11, lines 20-26);

wherein removing said process gas from said process chamber lasts from about 3 to about 12 seconds (via an Ar purge step, as per claims 4 and 21) (pg. 13, lines 1-3).

Regarding claims 9 and 16, a layer of tungsten metal is bulk deposited after the nucleation step with a layer of tungsten of desired thickness (i.e. forming, after introducing into, and removing from, said processing chamber, a bulk deposition layer of metal) (pg. 11, line 27- pg. 12, line 4).

As for claims 12 and 18, during a setup step before nucleation, the substrate is heated to a temperature of 425°C at an initial pressurization of 30 torr. The chamber pressure is reduced to 3.0 torr just before nucleation (i.e. establishing an initial pressurization in said processing chamber before introducing into and removing from said processing chamber said processing gas, with the initial pressurization being greater than the first pressurization) (pg. 12, lines 22-30).

For claims 13 and 19, silane (said hydrogen source) is introduced into the chamber while establishing said initial pressurization (pg. 12, lines 25-28).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 3, 5, 6, 10, 20, 22, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rajagopalan et al. (WO 98/51838) as applied to claims 1 and 14 above, and further in view of Tseng et al. (EP 0704551).

Rajagopalan teaches establishing an initial pressure of 30 torr while introducing a hydrogen source into the chamber (pg. 12, lines 25-30). A pressure control subroutine is utilized that contains a program code for controlling the pressure in the chamber by regulating the size of the opening of the throttle valve in the exhaust system of the chamber (pg. 9, line 30-pg. 10, line 12). Prior to/during nucleation, the chamber pressure is reduced to 3 torr (pg. 12, lines 29-30). After the nucleation step, the chamber is purged to remove the remaining process gases (pg. 12, lines 31-pg. 13, line 3). Rajagopalan does not expressly teach pressurizing the chamber to a second pressure level less than the first pressure level (claims 3 and 20), maintaining a pressurization of said chamber at a constant level (claims 5 and 22), introducing a

purge gas into said chamber while decreasing a pressurization of said chamber (claims 6 and 23).

Tseng teaches a method of processing semiconductor wafers in a vacuum processing chamber utilizing silane and tungsten hexafluoride as processing gases. Specifically, during the purging of the chamber, a purge gas is flowed while the chamber pressure is maintained. A second purge/pumping of the reaction chamber and process gas feed lines is conducted at a reduced pressure (col. 7, lines 52-59; col. 8, lines 17-25). Therefore, it would have been obvious to maintain or reduce the pressure while purging the reaction chamber as taught by Tseng in Rajagopalan's method in order to ensure all reactive species are removed from the processing area.

As for claim 10, Rajagopalan does not expressly teach a first pressurization of 15 torr and a second pressure level of 1-3 torr. However, it is noted that this processing parameter is considered result effective in the absence of critical notification of a specific pressure. A lower pressure will allow for ease of substrate de-chucking when removing or transferring the substrate between reaction chambers, while a higher pressure will prevent contamination of the substrate. Furthermore, the discovery of optimum values of result effective variables in known processes would have been obvious to a person of ordinary skill in the art at the time of the invention in the absence of unexpected results. Consult *In re Boesch and Slaney* (205 USPQ 215 (CCPA 1980)).

10. Claims 2, 7, 8, 15, and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Rajagopalan et al. (WO 98/51838), as applied to claim 1 above, and further in view of Govindarajan et al. (US 6,309,966 B1).

Rajagopalan does not explicitly teach introducing and removing occurs multiple times to nucleate said substrate with a layer of metal of a desired thickness (claims 2 and 15).

Govindarajan teaches an apparatus and method of tungsten via fill using a low pressure, two-step nucleation tungsten deposition process. Specifically, the deposition process recipe includes multiple step nucleation film growth (col. 5, lines 13-20). The first nucleation serves to permit as seed layer to nucleate uniformly on all the surfaces of the substrate while the subsequent nucleation provides a more accurate controllability to optimize the overall nucleation film thickness (col. 7, lines 38-50). Therefore, it would have been obvious to one skilled in the art at the time of the invention to utilize Govindarajan's multiple nucleation steps in Rajagopalan's method in order to control the uniformity and thickness of the nucleation layer prior to subsequent tungsten bulk deposition.

For claim 7, Rajagopalan does not expressly teach introducing said process gas for 3-5 seconds and removing said process gas after 7-12 seconds. However, it is noted that processing parameters such as specific times are considered result effective in the absence of critical notification of a specific time. As for the times for introducing and terminating the process gas, the time will be directly related to the flow rates of the process and purge gases. A greater flow rate will require less time for introducing and

terminating, while a lesser flow rate will require more time. Furthermore, the discovery of optimum values of result effective variables in known processes would have been obvious to a person of ordinary skill in the art at the time of the invention in the absence of unexpected results. Consult *In re Boesch and Slaney* (205 USPQ 215 (CCPA 1980)).

Regarding claims 8 and 24, Rajagopalan does not expressly teach repeating nucleation cycles to form a nucleation layer of tungsten upon the substrate while varying a ratio of said metal/tungsten source with respect to said hydrogen source during successive nucleation cycles.

Govindarajan teaches a control system that instructs the tungsten-containing gas source and the silane-containing gas source to flow a sufficient amount of gas mixture that results in a first silane-rich nucleation site layer for the subsequent second nucleation film growth and the bulk tungsten film deposition. The control system instructs the silane-containing gas source and the tungsten-containing gas source to flow silane and tungsten hexafluoride at a ratio within the range of approximately 2:1 - 7:1 for the first nucleation, and to flow silane and tungsten hexafluoride at a ratio of 1:2 for the second nucleation to optimize overall nucleation film thickness (col. 6, lines 1-20; lines 37-53). Therefore, it would have been obvious to one skilled in the art at the time of the invention to utilize Govindarajan's multiple nucleation steps with process gasses varying in ratio in Rajagopalan's method in order to form the appropriate seed layers and optimize overall nucleation film thickness prior to bulk deposition of the tungsten film.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Francis P. Smith whose telephone number is (571) 270-3717. The examiner can normally be reached on Monday through Thursday 7:00 AM-5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mikhail Kornakov can be reached on (571) 272-1303. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

FPS
/Michael Kornakov/
Supervisory Patent Examiner, Art Unit 1792

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